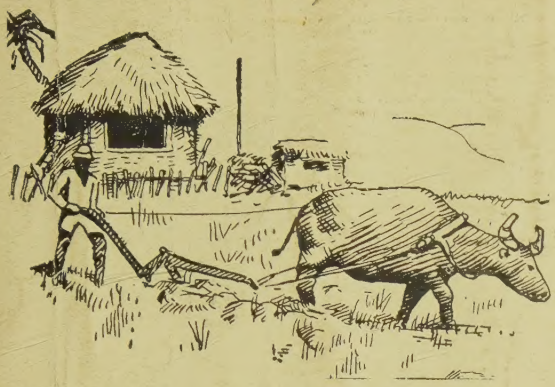
The Philippine Agriculturist and Forester



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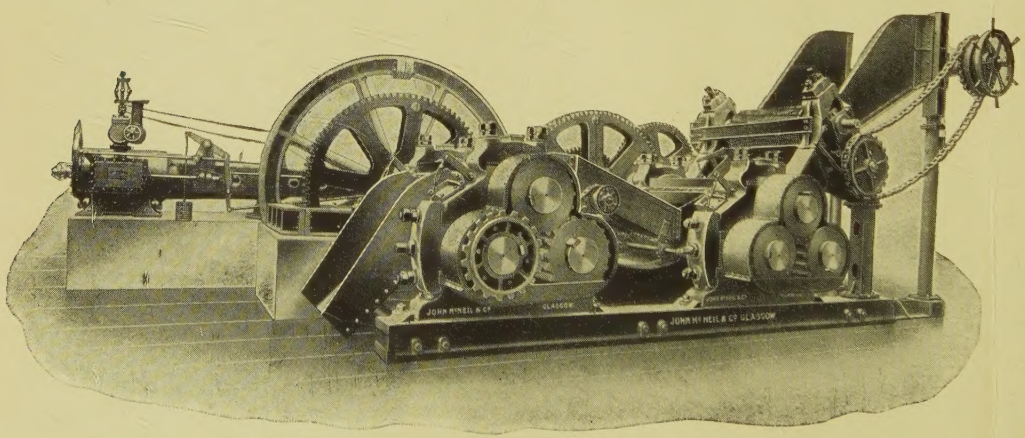

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THE PHILIPPINE AGRICULTURIST AND FORESTER

Vol. I. JUNE, 1911 No. 4

DOCTOR BARTLETT

Doctor Murray Bartlett, President of the University of the Philippines, was born in Poughkeepsie, New York, March 29, 1871. He was educated in Harvard University, from which he received its bachelor's degree in 1892, followed a year later by the degree of Master of Arts. He then entered the General Theological Seminary of New York, remaining until his graduation, in 1896. During the following year he was assistant minister of Grace Church, New York, one of the principal churches of the United States.

In 1897 Mr. Bartlett was honored with election as rector of the important parish of Saint Paul, at Rochester, New York. Through his eleven years in Rochester, he took always an active part in civic affairs and held a prominent place in his city. In 1908 the University of Rochester conferred on him the honorary degree of Doctor of Divinity.

At this time he was invited to become the Dean of the Cathedral Church of St. Mary and St. John, in Manila. His parish and friends strove to retain him in America, but his decision was that he should come to the Far East. In Manila he has continued to take an active part in all worthy public work. He was appointed a member of the Board of Regents of the University in 1909, selected, on the recommendation of Vice-Governor Gilbert, as Acting Chairman of the Board, and in 1911 chosen by his colleagues to be the first President of the University.

Doctor Bartlett brings to his new place considerable administrative experience, the cordial friendship and confidence of the leading men of the Philippines, and a character which the young men of the university may well take as their example. The President has a grand opportunity to achieve; and those who know Doctor Bartlett best are most confident that he will make the most of it.

THE DEPARTURE OF MR. BEATTIE

George W. Beattie came to the Philippines with the advance guard of educators in 1901, and was at once sent into the field as Superintendent of Schools of Occidental Negros. He left one of the model farms of southern California to come here, and has returned to enjoy it, after ten years of service. During his two years in Negros, his interest in agriculture found expression in the introduction of California oranges, lemons and sweet potatoes. The sweet potato is now widely known in the Islands, under his name; it is the only variety in cultivation by this college. His lemon is also spreading in cultivation, and was one of the articles helping Occidental Negros to win its prize at the last carnival.

In 1903, Mr. Beattie took charge of the Philippines Normal School, in which, until the founding of the University, were centered all the Government's efforts toward higher education. Through the hundreds of teachers trained under him, he has had a tremendous influence on educational work in the Philippines, and this influence continues to grow. Courses preparatory to medicine, law and agriculture were also given in the Normal School; all of the class recently graduated from this college had three years under him, and he can have no more appreciative admirers. In 1910 he became the head of the college of Liberal Arts, but resigned after one year.

Mr. Beattie is a strong, vigorous, resolute and clear teacher and administrator, absolutely consciencious, uncompromising, secure in the affection of his students. With his departure, the University has lost its most ample store of experience.

ABACA

By E. B. Copeland.

Following the plan explained in a report on the physiology of the coconut, in the last number of this magazine, a beginning has this year been made on the study of the physiology of the Abacá, *Musa textilis*, best known outside the Philippines as Manila Hemp. Less time has been put on the investigation of the abacá than on that of the coconut, but for several reasons the work on the abacá has, time for time, been more productive.

What we have been able to learn about abacá is so much of an addition to knowledge, as this is the first attempt to make any scientific study of the data on which its proper agricultural treatment must be based. Even on the purely practical side, there is very little information which can be taken as established and generally agreed upon. Even the production is subject to fluctuations hard to account for in a perennial crop not subject to general failures; there are no established standards of quality and the grading by so-called experts is largely arbitrary; and the markets are apparently as unsteady as the supply. Under such conditions, it seems well to let some statements on abacá in its commercial aspects precede the scientific report. For this commercial information, I am largely indebted to a compilation made by Toribio Vibar.

Part I.—Commercial and Industrial.

"Abacá is the name of the plant; the same word has been used in some parts of the commercial world as a name for the fiber extracted from it. In Albay most of the native people call the plant abacá, but the fiber they call *bandalá*. When abacá was first shipped into the United States it was invoiced as plantain bark fiber; but during the last fifty years it has been called Manila hemp,—the expression always used by the merchants of England and America to distinguish it from Russian hemp, Indian hemp, etc."

The plant and its use have undoubtedly been known to the natives for centuries; but it is still well under a hundred years since the export trade in the fiber began, and made it possible to raise it profitably on a plantation scale. The American whalers who once frequented these waters are credited with being the first foreigners to recognize its value. Attempts have been made to introduce abacá into India (as early as 1822), the Andamans, Borneo, German East Africa, the West Indies, and Florida; yet it still remains, as it always has been, a practical monopoly of the Philippines. In some of the foreign places mentioned, it would not thrive; in others, it was possible to cultivate it with apparent success. But labor was formerly cheap in the Philippines, and the culture well established here; and it is difficult for an industry on trial to compete with one grounded in custom. Labor is not now cheap in these islands, and if it remains as high as it is now in proportion to that in other tropical lands, there will be a chance of serious foreign competition.

While abacá is the foremost export of the Philippines, only a few of the provinces are greatly interested in it. These are, in the usual order of importance, Albay, Leyte, Sorsogon, Mindanao (island), Samar, Ambos Camarines, followed by Negros, Mindoro, La Laguna, Cavite, Bohol, etc. The real abacá region is a small belt along the east edge of the archipelago, extending from Davao northward to Camarines, and as an industry of less importance to La Laguna. The essential advantage of this region is a climatic one,—the absence of intense and prolonged dry seasons. But even here hardly a year passes without periods dry enough to make irrigation very profitable; as is amply proven by Davao experience.

The export of abacá during the last two years has been greater than ever before; but the price has fallen so much that the total value of the export has been less than

in recent record years. The fall in price has been partly due to the increased production; partly to greatly increased competition with other fibers; and partly, without much doubt, to a general lowering of the quality of the crop.

Grading the Fiber.

The last cause is hard to estimate, because as already noted, the grading is arbitrary, and the "good current" of one year may be the "fair current" of another. Indeed, such differences do not require years, but may be matters of hours, or meters. An elaborate classification of grades, ranging from (1) (the best) to (18), was given in the Philippine Agricultural Review of June, 1910. It is not in criticism of that attempt that it is observed that No. 17 of the list had recently been quoted 11.2% above No. 12. The fact is simply that the market is scrambled. Leyte current may be quoted 30% above Albay current; this would be all right if "Leyte" were merely a grade, like "Cochin" or "Mocha;" but the "expert" who grades the abacá cannot forget that Albay is a source of abacá. Paete abacá has a worse repute than that of Albay. The fiber from one stalk of Paete abacá was divided into two parts and presented to probably the foremost of the expert graders as half Paete and half Albay, with the request that he explain the difference in value; he cheerfully pointed out a variety of differences, all to the advantage of the supposed Albay sample.

There should be a standard quality of abacá, clean, white, uniform in length of strand, and of a fixed length, fineness, and tensile strength. Greater length, fineness and strength admit of mathematical expression, and each unit agreed upon can add a certain per cent to the grade. Shorter, coarser, or weaker fiber can be graded down in the same way. Color is the only quality of any importance to which intelligible mathematical expression cannot be given, and it can be graded by comparison with standard samples. Lack of uniformity is the worst fault abacá can well have, and should be graded down severely enough to make a mixed shipment a market outcast. Such a standardization of the market fiber is likely to serve as a protection of the producer against the defective judgment of the grader, who is an employee of a buying house. But it will serve a broader use, and is more urgently needed for the better position it will give abacá on the market of the world.

Abacá is not like coffee, or tobacco, or wine; it does not appeal to the senses; a machine can tell more about its real value than can any connoisseur. The producer has a right to know what he sells. The consumer has a right to know what he buys; and he is much more likely to buy a fiber which has a responsible guarantee than one the quality of which is uncertain. For the sake of our own abacá industry, we should send the consumers of other lands no fiber the quality of which, whether it be good, fair, or poor, cannot be guaranteed before the article is offered for sale.

To make this guarantee reliable, and the grading disinterested and impartial, the ABACA to be exported SHOULD all BE GRADED BY THE GOVERNMENT.

Machines.

The most conspicuous need of the abacá planter continues to be a satisfactory machine to strip the fiber. Besides the locally ill-famed Welborn-Bracy machine, which never offered the planter any ground for hope, there were in Manila five years ago two machines which repeatedly demonstrated that they could strip a better grade of fiber than is possible by hand. Neither survives; but their places are taken by others which promise well, and at least one of which is actually being sold. A machine to be satisfactory must be at least as cheap in operation, counting interest and depreciation, as hand stripping, must work rapidly enough so that its use will effect a material saving of labor, and must produce thoroughly clean fiber of uniform length. For widespread use, it must also be light, simple and cheap.

Uses.

While the chief use of abacá is for the manufacture of cordage, other uses are not without importance. Throughout a large part of the archipelago, cloth is woven from it. This bears in general the name of sinamay. As the abacá does not dye readily, it is commonly mixed with colored threads of cotton or silk. If there is much silk, the cloth may take its name, *jusi*. An excellent fabric of pure or mixed abacá, made in Albay, is called pinalpog, because beaten after weaving to make it soft. The Bagobos and Mandayas, and some other wild people of Mindanao, make exceedingly strong and heavy cloth of abacá. It is well and attractively dyed; but the dyeing is done in the thread, the different colors applied here and there, and so arranged that simple, plain weaving will develop the patterns,—a method obviously far too laborious for commercial use.

The use of abacá for the maufacture of fancy articles is hardly more than beginning to be appreciated in the Philippines, but as long ago as 1882 the Tropical Agricultural published a note by Perroutel, a French chemist, saying: "It is especially in France that tissues of abacá are best made and of greatest beauty. They receive all colors with equal perfection. Veils, crêpes, neckerchiefs, robes and women's hats, all of great beauty and high cost, as well as of wonderful durability are among the manufactures from the fiber. Beautiful shawls as well as vests and pantaloons, etc., are also made from Manila hemp." Fine and uniform strands of abacá are tied end to end in parts of Batangas, and in some other places, and sold for export in skeins of about one pound, at a price which sometimes reaches one peso a skein. This fiber is used in Europe for making braids from which in turn hats are made. In the industry of tying the fibers into one continuous thread, there is already serious competition from the Japanese.

At Daraga, and as a novelty in some other places in the Islands, hats are woven directly from the fiber. These are very fine and beautiful; but as they are likewise expensive, and not correspondingly durable, there is no commerce in them.

Although "Manila" has long been the trade name of a very tough paper, and although it is nearly twenty-five years since a Barcelona firm of paper-manufactures reported most favorably on the waste from stripping as a raw material for paper, it is only within the past five years that there has been any business in this article. The present price in the field, paid for the dry waste, is two to two and a half pesos a picul.

The fruit of abacá is commonly stated unconditionally to be inedible. Mr. Vibar says on this point: "I myself had the pleasure of eating delicious ripe fruit of abacá when I was living in an abacá country, in Albay. There are varieties whose fruits are almost entirely filled with seed, but there are also others whose fruits are pulpy, and truly edible."

Local Statistics.

By my direction, Mr. Vibar sent letters to the governors of all provinces having any considerable abacá industry. Some of these have been unanswered, and some of the statements sent in are contradictory or confused; but in part the answers contain information of interest and value. It is evident that in all of these provinces there is a considerable area in abacá which is still too young to be productive; and this shows that there has recently been a large increase in the area devoted to this crop. The maximum age of this immature abacá, and therefore the time within which the extension of area can have taken place, varies from two to four years in the different provinces.

It also appears that there is in nearly or quite all of these provinces adult abacá which is not at present being harvested. This is the case on such a scale that it can have only one explanation: that the price of the product is so low that the extraction

and marketing of the fiber does not pay. Factors working with the low market price to produce this result may be remoteness from market, scarcity and high cost of labor, and the use of unsuitable land. At any rate, the situation is such that an increase in the price is sure to result in an immediate increase in the crop; and this condition must tend to check a rising market. It would take a very great increase in the demand to bring back the high prices of a few years ago.

With regard to quality, most of the provincial governors report that first and second grade fibers are produced. As a matter of fact, an exceedingly small part of the crop ought to be called first class. It is beyond question that the low grade of the bulk of the abacá is responsible for the limited demand, which in turn causes the present low price. Nearly all the reports as to the yield per hectare are too contradictory to be used, the reason for which is probably that the hectare is not really a familiar measure of the area of lands in abacá.

The data as to cost of planting and bringing to maturity bear internal evidence of being more reliable. There are two reasons for this difference:—the figures are in some cases given for the thousand hills, which is roughly one hectare; and the number of hectares is more likely to be known in the case of recently planted land than in that of old fields. The cost of putting land into abacá of course depends on its previous condition, as already in cultivation (a most unusual case), in cogon (also unusual), in brush, or in forest. In Oriental Negros, a province which has advanced materially in the past decade in the importance of its abacá industry, the Governor puts the cost in general at sixty pesos a hectare. The Governor of Samar states that expenses vary from town to town; in Gandara, where the product is best in quality, the expense of planting and care until the time of harvest amounts to forty-four pesos.

In Capiz, the expense in planting is twenty-five or thirty pesos, and the additional cost of care up to the time of production is twenty pesos. In Sorsogon, the cost of clearing, cleaning, and planting one hectare is about forty pesos. For the Moro Province, figures printed in the *Mindanao Herald*, and indorsed by the provincial government, contain items probably included in the sums given for other provinces amounting to ninety pesos a hectare. These figures must apply especially to the district of Davao, and the greater expense than elsewhere is largely due to the high cost of "seed."

Does abacá pay? For the Islands as a whole, the answer depends upon the value put on money. If interest is reckoned at ten per cent—regarded in many countries as a very satisfactory return—abacá at present prices and with the present general grade of fiber is probably a little more than paying it. But if interest be reckoned at twenty per cent, the business for the whole archipelago is now probably paying less than eight, and a large part of the product is being put on the market at a loss. And this is the actual situation. The hacendero has his money invested in the industry. He can not get it out. He may either lose it entirely, or have his crop stripped, at no cash outlay to himself, and receive for his share of it a sum which is better than nothing, even if it is less than reasonable interest and the depreciation on the investment. This is the force of the statement already made, that a new business cannot compete with an established one. Any man who introduces abacá elsewhere should understand that he must compete with a land which has a tremendous crop, which it is ready to market at a loss rather than not market it at all.

Can abacá pay? It certainly can, and for many planters does. Under any decent conditions as to location, it will pay at present prices, if the planter is skilful enough to secure a decent crop and to have this so harvested that it shall be of the best possible grade. It costs more to

strip so as to produce a high grade, and the amount produced is usually materially less; but it is the men who adopt this method who are making money. Like any other farming, abacá growing is at once a trade and a business. No one who can qualify as tradesman and business man need find anything in the low state of the abacá industry as a whole to discourage him in the least. In the Moro Province estimates there is an arithmetical error whose effect is to divide the returns by ten; and in spite of this the business is made to look promising!

Part II.—Experimental.

The Root.

The experiments on the physiology of the root reported here were performed by A. F. Navarro, and deal with the growth, and with the absorption of water and solutions of potassium nitrate. The root-cap varies in length from 0.5 to 1.5 mm., and the growing region, measured from the extreme tip, is usually, but not always, less than 5 mm. in length; the larger part of the elongating region is therefore outside the cap. In the coconut, this relation is reversed, practically the whole elongating region being protected by the cap. Other respects in which the abacá is less protected against possible injury by the environment of its roots are the presence of root-hairs, and the absence of a hard hypodermis.

The measurements of the growth of roots were made in the manner developed by myself for work of this kind on the coconut, using split bamboo to identify and protect the subjects of experiment. Mr. Navarro made three series of measurements of growth. The first was preliminary in nature. It included four aerial roots, the average daily growth of which was 1·25 mm., and six ground roots, the average daily growth of which was 4.67 mm. Thirty-eight roots were used in the second series. Of these, some did not show any growth, perhaps because of invisible injury in manipulation; some were injured in one way or another during the experiment; some ceaesd to grow without evident injury; and some grew all the time. It appeared in practically all individuals that the growth was far from uniform. Table I shows the growth of seven of the most continuously active roots in this series, the figures given being the growth since the preceding measurement, expressed in millimeters.

TABLE I.
Growth of Abaca Root.
Beginning September 19.

Date.	No.	I	II	III	IV	V	VI	VII
September 21		19	20	2	Begun this date.			
22		2	9	4	2	15	3	10
23		9	6	5	7	1	3	13
24		8	7	5	4	12	15	26
25		6	4	3	3	20	25	6
27		5	4	1	2	15	12	22
30		11	5	36	31	11	14	10
October 3		20	12	3	17	15	10	broken
5		7	18	6	20	13	8	
7		3	7	3	20	10	9	
Average		**5.0**	**5.1**	**3.8**	**6.6**	**7.0**	**6.2**	**9.6**

The third series of growth measurements was made in connection with the study of the absorption of water, but it is more convenient to present the results on the two subjects separately. Table II does this for the growth. The figures, as before, are total growth for the preceding period; but the averages, as before, are *per diem*.

TABLE II.
GROWTH OF ABACA ROOT.
Beginning October 24.

Date.	No.	I	II	III	IV	V	VI	VII	VIII	IX
October	25	5	4	4	4	13		8	8	
	27	9	6	19	7	12		22	13	
	29	9	8	8	13	16	9	14	18	
	31	19	12	14	10	15	15	16	16	
November	2	14	11	5	15	16	15	18	19	
	4	14	15	22	12	10	13	18	12	
	6	12	17	11	8	20	13	11	14	7
	8	15	11	9	17	10	25	5	10	15
	10	12	12	8	17	25	15	15	10	11
	12	8	24	7	8	5	5		14	4
	15	13	30	3	11	7	10	22	17	10
Average		**5.9**	**6.8**	**5.0**	**5.6**	**6.8**	**6.3**	**6.8**	**6.8**	**4.6**

At the average rate of growth of these roots, somewhat more than 6 mm. per diem, it will take less than six months for a root to reach a length of one meter. This is probably faster than the average growth of all the roots of an average plant; but it probably justifies the conclusion that a considerable number of the roots of a vigorous young plant advance through the soil at this rate. Like the coconut, the abacá is a plant many of whose roots are near the surface, but its roots advance more rapidly. In good and properly moist soil, as abacá is ordinarily planted, the roots of neighboring plants will begin to overlap with less than a year's growth, and subsequent cultivation should be very shallow. There is active competition between the roots of grown abacá; but in dealing with abacá other considerations have more weight in determining the proper interval between plants than does the competition between the roots.

Mr. Navarro also made careful determinations of the amount of water absorbed by the roots. His results have not been correlated with the transpiration and with the varying factors of the environment, so as to make it a matter of interest to publish them in full at this time. His general average of daily absorption by each root, including some which took up but very little water, is not quite one-third of a gram. This does not include one series of determinations, on three roots only, selected as especially active, the daily absorption by which averaged over half a gram, distributed through the day as follows:—

6 p. m. to 6 a. m.....0.1941 gram
6 a. m. to 12 m.....0.1005 gram
12 m. to 6 p. m.....0.2138 gram.

This result indicates that as in the coconut, the rate of absorption is decidedly intimately dependent on the rate of transpiration, the hours of most rapid absorption following closely after those when the water is most rapidly given off.

THE LEAF.

Abacá is propagated by the use of seed, of the suckers springing from the base of the erect stem, or by the use of the underground stems. The first is of course the slowest, and is never used in practice, except exceptionally, where suckers are scarce and expensive. The use of the rhizomes is likewise of almost no practical importance. Rhizome sections ten centimeters long will produce new plants about as rapidly as will the small suckers in use in La Laguna, but less quickly and at first in less number than the larger suckers in commoner use in the southern islands. No stem is visible above the ground, but as in other related plants a false stem is made

by the bases of the leaves. Measurements of rate of growth are naturally made on the leaves; and of these the parts actually growing are far from the visible parts.

While the underground stem, or rhizome, is perennial, the erect stalks, which produce the fibers, live only long enough in nature to produce on each one bunch of fruit. One rhizome bears at one time, as a rule, twelve to thirty of the erect shoots, of various sizes, including basal branches. New suckers present themselves on the swollen bases of the old ones, appearing at first as swollen knobs. When one of these is ten to fifteen millimeters high, it cracks at the top, and the first leaf-tip presently emerges from this crack. The growth of the first leaves is of course slow; the rate increases, under suitable conditions, without interruption, from this time until maturity. The rate of growth of the leaves of shoots of different ages is shown in the foll wing table of measurements, made by S. Asunción.

The figures show the average growth per diem for the preceding interval of days. The observations on the youngest and oldest plants began March 2. Those on the plants of medium size were at a different time, probably in less favorable weather.

TABLE III.

Growth of Shoots of Different Ages.

Average Height:	60 cm.			200 cm.			360 cm		
Plant. March	6	11	18				6	11	18
I	2.2	4.7	4.6	5.7	1.1	4.7	9.6	5.6	7.2
II	4.5	2.7	4.5	3.7	1.5	3.9	7.0	9.1	9.6
III	0.1	0.5	2.5	2.1	3.0	5.4	4.1	1.0	1.4
IV	2.0	1.6	2.3				7.9	8.0	11.9
V	1.0	1.2	1.4	4.7	2.3	2.4	4.0	4.5	10.8
VI	4.8	5.5	0.3	2.7	0.6	2.9	7.0	4.8	1.8
VII	2.1	1.7	4.5	6.7	1.8	6.0	1.7	1.3	0.9
VIII	2.3	1.4	0.8	4.4	4.2	4.9	6.9	6.7	4.4
IX	3.4	1.0	1.0	1.1	2.4	2.9	4.7	4.3	3.2
X	2.3	1.0	2.7	5.9	3.1	0.3	12.6	7.1	10.1
XI	4.8	4.5	6.6	5.1	0.0	0.2	10.6	5.6	9.3
XII	2.2	3.7	1.5	6.1	2.0	4.8	5.5	5.1	11.5
XIII	2.9	4.2	2.8				2.0	3.5	10.3
XIV	4.2	3.1	4.1				3.1	2.0	2.1
XV	2.9	3.0	2.1				11.9	10.2	6.1
XVI	1.3	3.1	0.1				9.9	10.2	5.8
XVII	4.7	3.2	1.4				1.6	4.7	5.8
XVIII	2.3	1.2	2.2				11.1	9.0	6.4
XIX	3.8	5.0	4.5				6.0	2.9	11.4
XX	0.7	0.5	0.5				8.0	6.7	5.0
Average	**2.6**	**2.4**	**2.5**	**4.3**	**2.0**	**.4**	**6.7**	**5.5**	**6.7**

All the plants serving as subjects of this series of measurements were growing in the original abacá plot of the college. This is planted on the sloping wall of a shallow ravine, in a place kept humid by the contour of the land, by the creek in the ravine, and by scattered shade from trees of moderate size. Similar observations as to relation between size of plant and rate of growth were made by other members of the class.

On the relation of the illumination to the growth, I had especially full and careful measurements made, because this is a subject of some disagreement, and one of very great practical importance. It has in the past been assumed by most writers that abacá is a crop which demands shade. As a matter of fact, it is the general, but not universal practice in the older abacá provinces to shade the fields. This obviously and certainly serves to protect the abacá against danger of injury from drought. It would protect any other crop against the same danger; the question is as to

whether or not the abacá as a rule gains as much from this protection as it loses. It is generally agreed that some crops require shading, but that most of them are better off without it. In each single case, this depends on the one hand upon the local and climatic conditions, and on the other upon the specific water-relations of the plant. Some crops will thrive without protection where others will not. As a general rule there should be grown in a place the crops which can endure all the sunlight in it. Maize and cane thrive where it is too dry for abacá; let them have such places. It is the experience of some planters in other places, and of all the planters of the Davao district, that it is possible to grow abacá without shade and to get a much larger yield than is ever obtained from shaded fields.

The trees which provide shade also protect against the wind. As all parts of the Philippines except southern Mindanao are more or less subject to typhoons, and as abacá is for the time destroyed by very heavy wind, this protection has its value. Yet even this protection is no unqualified advantage; for wind promotes transpiration, and probably acts mechanically to increase the amount and strength of the fiber.

On the other hand, shade inevitably decreases the photosynthesis or formation of carbohydrate material by the plant; and the fibre, practically as a whole, and the rest of the plant in large part are composed of this material. The general thriftiness of the plant must be directly proportional to the photosynthesis; and this in turn, within reasonable limits, is proportional to the illumination. At any rate, it is absolutely dependent upon the illumination. F. Cevallos has determined the increase in dry weight of plants grown in the abacá plot, shaded to the extent commonly regarded as locally necessary, and of others grown in full sunshine. Reduced to square meters of leaf surface, and hours of exposure, it appears that:—

Shaded plants increased in weight 0.1 to 0.37 grams.

Plants in the sun increased in weight 0.5 to 1.68 grams.

These experiments were made according to Sachs' method, using paired parts of leaves previously darkened, but left on the plant during the experiment. Because of its uniform veins, the abacá is an ideal subject for such experiments. This investigation will be continued during the coming year.

Returning to the growth of plants in shade and in full sunlight, we will see that this difference in the production of carbohydrate has its natural influence on the growth. Table IV shows measurements of S. Asunción on plants in the abacá plot and in full illumination. These measurements began in September, but to economize space only the last part of the series is published. The general result was the same at all times. The figures are millimeters of growth per diem for the preceding interval, the first being of two weeks.

TABLE IV.

Date:	Jan. 28;	Feb. 5,	12,	19;	March 1,	6,	11,	18.
Plant.				In Shade.				
I	3.3	2.2	9.4	6.2	4.9	4.1	3.5	5.3
II	6.1	4.1	5.7	4.3	3.4	5.9	2.3	3.0
III	7.3	1.8	2.8	6.1	10.6	8.0	2.0	4.0
IV	7.0	5.8	5.5	6.4	9.1	7.0	8.0	2.5
V	3.0	5.4	10.8	4.6	3.7	5.0	12.6	9.4
VI	6.0	3.1	7.7	11.2	15.5	6.8	6.9	10.8
VII	6.2	5.3	5.3	6.0	11.5	2.0	3.1	3.9
VIII	2.5	1.5	7.1	8.5	5.0	8.2	7.2	4.5
IX	2.0	0.7	4.0	3.8	11.0	6.0	3.3	2.4
X	3.5	0.8	4.2	2.5	3.2	4.0	5.1	3.5
XI	7.0	3.0	2.3	5.6	6.8	4.2	1.8	2.0
XII	7.5	4.2	6.4	8.2	5.7	3.2	1.1	4.1
XIII	3.1	4.0	2.0	1.7	4.0	3.0	4.6	4.7
XIV	5.0	1.4	1.8	3.0	3.9	4.0	4.1	1.7
XV	1.4	0.3	4.0	6.1	6.0	8.0	1.4	1.9
XVI	5.1	6.4	3.1	7.7	9.3	9.5	8.0	4.8
Average	**4.7**	**3.1**	**5.1**	**5.7**	**7.0**	**5.9**	**4.6**	**4.3**

	In open sunlight.							
I	4.3	4.6	6.0	5.0	5.9	4.0	6.3	4.0
II	6.4	3.3	9.3	8.8	10.9	8.2	9.2	7.1
III	8.3	7.2	9.3	8.2	10.5	8.5	7.0	8.1
IV	10.6	7.5	9.7	13.3	6.3	6.1	8.3	8.0
V	7.0	7.4	10.0	11.0	14.2	11.1	9.0	8.4
VI	7.5	2.2	9.9	12.4	8.0	12.3	9.5	8.1
Average	**7.4**	**5.4**	**9.0**	**9.1**	**9.3**	**8.4**	**8.2**	**7.3**

The general average daily growth of the shaded plants for this period was 5.05 mm., and that of the fully illuminated plants 8.01 mm. For the entire period of his measurements, Asunción gives the averages as 4.7 mm. and 7.9 mm., respectively. The more rapid growth during the period here reported may have been due to the natural increase in rate as the plants grow larger, or to better weather conditions. In the figures given above, it is evident that the growth of the plants in both places was most rapid during the latter part of February and the first days of March. The same observation was made on the coconuts under observation at that time. This was a time of unusually constant sunshine, with ample water still in the soil.

Not only do the plants in the open light grow more rapidly, but the growth of each leaf continues longer; or it would perhaps be more correct to say that the longer continued growth of the individual leaves is a reason for the more rapid growth of the plant as a whole. This difference in the growth of single leaves is shown by the following summary, showing total growth of the growing leaves from March 2 to March 26, during which time they were measured seven times. The figures are millimeters.

TABLE V.

Growth of Single Leaves.

Plant.	I	II	III	IV	V	VI	Average.
	I Full Sunshine.						
Leaf 1	705	1258	537	1022	620	440	**767.0**
2	60	118	125	241	102	91	**122.8**
3	4	14	35	91	118	71	**55.6**
	In Shade.						
Leaf 1	752	638	421	647	395	382	**539.2**
2	24	15	8	58	47	7	**26.5**
3	2	3	2	23	2	0	**5.3**

Not only do the plants grow more rapidly in full suushine, and the leaves grow for a longer time, but each leaf becomes wider, and the leaves live longer, so that a plant bears more leaves at a time. Half-grown plants in the open sunlight have about seven leaves, while those of the same size in the abacá plot have most often five. Asunción reports the average life of a number of leaves in the plot as 67 days; while the average life of the leaves of plants of the same age in the sun was found to be 101 days. The average width of these leaves is 30 cm. in the shade, and 39.2 cm. in the open sun.

I do not feel that we have any figures which can be trusted as showing what should be a satisfactory rate of growth for this crop. There are two chief reasons for this: the college is not in a very good locality for this crop; and we have no adult plants except under shade. Such a standard, to

be easily used, should be based on the growth of the most rapidly growing leaf. The highest figure we have for this is 1165 mm. in 19 days, or nearly 61 mm. a day. For one period of five days, this plant averaged 103.6 mm. a day. The general average for the plants in Table V, growing in open sunlight, is 32 mm., and the average for the most active plant 52.4 mm. Growth more rapid than this is frequently observed. To understand the great difference between these figures and those given in Tables III and IV, it must be noted that the latter show the increase in height of the plant as a whole, and measurements of this will never show the growth of the most active leaf. On medium-sized plants, three leaves always grow in sunshine, but often only two in the shade.

Some experiments have also been made on the transpiration, by F. Cevallos. Among these were some on entire plants, previously transplanted into boxes or cans, and after an interval for recovery weighed daily, with the container. As the subjects weighed from 50 to 190 kg., and were kept in the open, where they were often rained upon and it was out of the question to absolutely prevent the rain from reaching the soil, these experiments do not pretend to great accuracy. The plants were weighed daily for nearly two months. The results were an average loss of weight which varied from 630 grams daily by a plant with a leaf area of 1750 cm. sq., to 1350 grams daily by a plant with a leaf area of 7100 cm. sq. The less rapid transpiration by the large plant was probably due to its being less perfectly accommodated to its artificial situation. Records were kept as to the temperature, pressure, cloudiness, wind, and rain; the transpiration was observed to be influenced by the last three factors, in the usual way.

SUMMARY.

I

It is in the interest of the abacá business of these islands that every producer have the privilege of having his product officially graded by the Government, and that all abacá exported be so graded.

The low price at present brought by abacá is largely due to the poor quality of most of the fiber marketed.

If intelligent care be taken to produce good fiber, the abacá business is profitable at present prices.

II

The structural and physiological characters of the abacá root are such that it can not endure dryness of soil.

The large size of the leaves, and the absence of special structures to restrict the loss of water make it necessary that the roots supply water amply at all times.

As compared with plants in open sunlight, shaded plants grow more slowly, their single leaves grow more slowly and cease to grow sooner, and are narrower; and the leaves live for a shorter time, so that the plant bears fewer leaves at one time. Shaded plants therefore have much less leaf area than those well illuminated. And area for area the shaded leaves are much the less efficient in the production of food.

Therefore, abacá grown where the climatic conditions are such that it can be made to endure open planting has a very great industrial advantage over abacá grown where shading is for any reason necessary.

I desire to express my appreciation of the work of the students who have aided me in the collection of the data on which this paper is based.

Spraying Tests of Some Common Insecticides on Farm Crops

One of the most important ways of fighting insects is spraying. Spraying is generally practiced in parts of the world where agriculture is highly developed, especially in western Europe, the fruit-growing districts of America, and a very few countries in the tropics. Its practice will sometimes give bad results or even cause great destruction if the work is not properly done. The failure in that case may be due either to carelessness or to the lack of understanding of how to make the application of the insecticides. A large number of chemicals used as insecticides are poisonous to plants, and, therefore, by wrong use of them, the plants may be badly injured or killed. The loss in this case is not only the plants which are destroyed, but also the money invested in the purchase of the insecticides. In order to do this work economically and at the same time practically, it is advisable to make preparatory tests, that is, to make several experiments on the effects of the different dilutions of the insecticides being prepared, upon various crops. These dilutions are generally applied to small areas, where different plants are grown. By these tests with careful observation and examinaton of the effects on the different crops, the right dilution will be obtained and can be recommended for general use on field crops of the same kinds. The dilution and the amount to be used should be taken by the farmer in such a way as not to injure the plants, but to kill the insects that attack them.

In connection with the subject of spraying and in its study in the Philippines, the class in Economic Entomology at the College of Agriculture has been kept busy for several months in finding out the different effects of the various dilutions of some important insecticides upon field crops.

The results obtained from the spraying tests are as follows:

I

KEROSENE EMULSION.

For our purpose we have used the following formula:—

Hard soap.....0.25 lb. or 113.4 grams.
Water.....0.25 gal. or 0.9465 liter.
Kerosene.....0.50 gal. or 1.8930 liters.

PREPARATION.

The soap was dissolved in the 0.9465 liter of boiling water; it was first shaved fine, before putting it in the water. The 1.8930 liters of kerosene was warmed. After the soap was dissolved, the solution and the kerosene, while both were hot, were poured together into a vessel and churned for several minutes with a spray pump until the whole mixture became like a cream and a little later appeared like a soft butter. The mixture was again churned before applying it to the plants. Dilutions of different strengths were prepared and used, and called one-third, one-fifth, one eighth and one-tenth normal. These different dilutions were applied to the following plants:—

Mulberry, (Morus alba); tomato, (Lycopersicum esculentum); opo, (Cucurbita pepo); okra, (Hibiscus esculentus). A day after the application of the mixture, the plants were examined and the following effects were carefully observed:—All dilutions were without effect on mulberry tree, while on the other plants they showed some effects, but the degree of injury varied with the strength of the solutions. The one-tenth normal solution had very slight effect on the foliage, but the other solutions were detrimental to the plants. The one-tenth normal solution can be recommended for general use on garden crops.

Effects of the Different Dilutions upon the following Plants:—

Names of Plants treated.	*Strength of solution* $\frac{1}{3}$ *normal.*	*Strength of solution* 1/5 *and* $\frac{1}{8}$ *normal.*	*Strength of Solution* 1-10 *normal.*
(1) Mulberry, (Morus alba)	No effect	No effect	No effect.
(2) Tomato, (Lycopersicum esculentum)	Bad effect	Not so bad as the first	Very slight effect.
(3) Opo, (Cucurbita pepo)	Bad effect.	Not so bad as the first	Very slight effect.
(4) Okra, (Hibiscus esculentus)	Bad effect.	Not so bad as the first	Very slight effect.

Kerosene emulsion is one of the most important of the insecticides. Kerosene is the basis of the mixture, the part which does the killing; soap will also kill insects, but its chief use is to neutralize the solution. It is also used for the purpose of having a sticky, stable substance uniformly distributed on the plants. Kerosene emulsion is a contact poison, killing insects by shutting the spiracles or the breathing organs. It is especially used to kill the insects that suck the juice of plants. Such insects, for instance, are the Hemiptera or true bugs, such as the squash bug and its relatives.

II

Resin Wash.

We use the following formula:—

Resin	0.2 lb.	=90.72 grams.
Sodium Hydroxide (NaOH)	0.1 lb.	=45.36 grams.
Tallow (fat)	0.1 lb.	=45.36 grams.
Water	4.40 gal.	=16.65 liters.

PREPARATION.

The sodium hydroxide (NaOH) was dissolved in 0.5979 of a liter of water. After the sodium hydroxide was dissolved, the resin and the tallow were added to the solution and dissolved with the application of a moderate heat; and while the solution was kept hot, the remaining water was added to it little by little. The mixture was stirred constantly while adding the water; when all the water was poured into the solution, the whole mass was set aside to cool. After cooling, it was ready for use. The solution was applied to the following plants: Camote, (Ipomea Batatas); sugar cane, (Saccharum Officinarum); cabbage, (Brassica oleracea). The plants were examined on the day following the application and the solution was found to have no effect on the plants, except that there was a very slight injury done to camote.

A small area of sugar cane which was badly attacked by scale insects was treated with the same prepared solution; the plant was not affected by the spray, but this spray killed all the insects infesting the cane.

Resin wash is a contact poison; it kills insects by closing the spiracles; it is used to kill insects which suck the juice of plants. The sodium hydroxide is the basis which does the killing; resin, soap, and tallow are used to neutralize the mixture; they are also used to make the whole mass sticky and stable in such a way that the mixture when applied shall stick to the body of the insects, hence shutting the spiracles or the breathing organs.

III

Bordeaux Mixture.

Solutions of different strengths were made according to the following formula:

FIRST FORMULA.

Copper Sulphate	1.2 lbs.	=544.32 grams
Quicklime	0.8 lb.	=362.88 grams.
Water	4.4 gal.	= 16.65 liters.

SECOND FORMULA.

Copper Sulphate	1.2 lbs.	=544.32 grams
Quicklime	0.8 lb.	=362.88 grams.
Water	3.0 gal.	= 11.35 liters.

THIRD FORMULA.

Copper Sulphate	1.2 lbs.	=544.32 grams
Quicklime	0.5 lb.	=226.80 grams.
Water	4.0 gal.	= 15.14 liters.

PREPARATION.

The copper sulphate was dissolved in one liter of hot water; in another vessel the lime was slacked with a liter of water. The slacked lime was added slowly to the copper sulphate solution and while adding the slacked lime the solution was stirred constantly. The remaining water was added afterwards and the mixture was ready for use. The three different solutions were prepared in the same way and they were applied to the following plants:

Citrus; tomato, (*Lycopersicum esculentum*); Camote, (*Ipomea Batatas*); gabi, (*Colocasia Antiquorum*); egg-plant, (*Solanum Melongena*); squash, (*Cucurbita Pepo*); pepper, (*Capsicum annuum*); okra, (*Hibiscus esculentus*); papaya, (*Carica Papaya*).

These plants were examined on the day following the application of the mixture and they were found uninjured. But it was observed that the insects attacking the plants were all driven away or killed. Five days after the application of the solution the poison was removed by a strong rain and on account of the removal of the insecticide from the foliage, the insects again began to frequent the plants.

Copper sulphate is the basis of the mixture which does the killing. It kills the plants if not properly used, so it is necessary to use some substance to neutralize the mass, and for this purpose quicklime is employed. Bordeaux mixture is both a fungicide and an insecticide. If it is used as an insecticide it is a stomach poison, that is, it kills insects that eat the foliage.

IV

White Arsenic.

Three solutions of different strengths were made, according to the following formulae:—

FIRST FORMULA.

Arsenious oxide	0.033 lb.	=15.2 grams.
Quicklime	0.066 lb.	=30.4 grams.
Water	3.5 gal.	=13.104 liters.

SECOND FORMULA.

Arsenious oxide	0.12 lb.	=54.0 grams.
Quicklime	0.12 lb.	=54.0 grams.
Water	3.5 gal.	=13.104 liters.

THIRD FORMULA.

Arsenious oxide	0.15 lb.	=70 grams.
Quicklime	0.066 lb.	=30.4 grams
Water	2.64 gal.	=10 liters.

PREPARATION.

The arsenious oxide and lime were boiled with water for about 30 minutes. Only a small amount of water was used in dissolving them and the remaining water was added to the solution when applied to the plants. The first dilution was applied to the following plants:

Egg plant, papaya, camote, tomato, okra, cabbage, Irish potato, and carrot. This dilution did not have any effect on the plants. The second dilution was applied to these plants; papaya, okra, pepper, calabasa, citrus, batao and cincamas. None of the plants in this case were injured except the cincamas, and the effect on it is very slight. The third dilution was applied to the following plants: Camote, egg plant, tomato, gabi, calabasa, lettuce, pepper, cincamas, raddish, okra, and Irish potato. All the plants in this application were badly injured, except the Irish potato upon which the effect was very slight. The leaves of the plants were all dried. After the application of these solutions insects that frequented the plants were no longer to be found on the crops. They were either driven away or killed by the poison.

Arsenic is the basis of the mixture and the substance which kills the insects. It also kills plants if it is not properly handled, so in order to prevent such damage to the foliage lime is employed, and acts as a neutralizing agent. Arsenates are stomach poisons being used to kill the insects which eat the leaves of plants.

Carbon Bisulphide (CS^2) and Its Application to Anay Nests.

Some favorable results have been gathered from the application of carbon bisulphide, to a number of anay nests. Anay, known as white ants, are found in abundance around the college farm. Many can be found under the coconut groves, in the open fields where crops are raised, and in the posts of the houses in the college barrio. These insects are very destructive to houses; and when they can get into the houses, they even destroy books, clothes, etc. Owing to the abundance of these insects in the college barrio many posts of houses, and according to my own observations valuable books have been destroyed by them.

Results of the Application of Carbon Bisulphide on Anay Nests.

Three anay nests were treated with carbon bisulphide. The first nest was treated with one-half of a bottle (250 grams) of carbon bisulphide and each of the last two nests was treated with one-fourth of a bottle (125 grams). The nests were about 70 to 80 centimeters in diameter and 70 centimeters in depth.

The solution was poured into a perpendicular hole in each nest; each hole was made deep so that every part of the nest could be reached by the gas. The hole was made by a pointed rod; the top of each hole was immediately closed after applying the carbon bisulphide in order to prevent the gas from escaping into the air, for carbon bisulphide is very volatile. A moist, sticky earth was used to cover the holes.

These nests were dug out and examined carefully on the following day: In the first nest, which was treated half a bottle of carbon bisulphide, all the anay were killed; the second and the third nests, which were treated with one-fourth bottle of the poison, gave practically the same result as the first. A dead snake was found in the first nest; it was about 30 centimeters in length; and a dead queen anay was found in the second nest. She was about $3\frac{1}{2}$ centimeters long and 8 millimeters in diameter.

Carbon bisulphide is one-fourth heavier than water, its specific gravity being 1.29 at the freezing point of water. It is very volatile, evaporating with great rapidity when freely exposed to the air. One volume of the liquid is said to give 375 volumes of vapor upon evaporation.

Cost.

One bottle of carbon bisulphide (like that used) costs the College of Agriculture about 50 centavos. In our experiment it cost about 12 centavos to kill the anay in one nest, but I believe that this can be reduced to about 5 centavos. Carbon bisulphide also kills many varieties of insects such as weevils, cabbage root maggots, etc. It is also used to preserve grain; in such cases the grain is stored in a closed box and the gas is applied to it. It has been found by experimental test that carbon bisulphide does not injure the grain.

I have reviewed in detail some of the work of the class in economic entomology. The reader will be able to deduce from what I have said that there are two classes of poisons in common use; one kills insects by being eaten by them and the other kills insects by contact, that is, closing the breathing organs. All noxious insects are biting or sucking.

Felipe O. Cevallos.

The Philippine Agriculturist and Forester

Organ of the Student Body of the Philippine College of Agriculture Published Monthly During the School-year

ENTERED AT THE POSTOFFICE AT LOS BAÑOS, LAGUNA, AS SECOND CLASS MAIL MATTER

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BOTANIC GARDENS

'sLANDS PLANTENTUIN.—*Buitenzorg, January*, 1911.

When, in January, 1905, the Department of Agriculture was founded in the Dutch Indies, the institution known under the name of 'sLands Plantentuin (Botanic Garden of Buitenzorg), and which previously formed a division of the Department of Public Instruction, was suppressed as such, and its various services were distributed among the technical divisions of the new department.

More recently, however, it has seemed better to group anew the Laboratories in which purely scientific researches are carried on, and it has been decided to form in this way an independent service, for which there shall be reestablished the old name of 'sLands Plantentuin; this not only to indicate that, in this institute, the work will be chiefly botanical in nature, but also because of the importance which the former director, Melchior Treub, succeeded in giving to the name of 'sLands Plantentuin in the history of the natural sciences.

Since the First of January, the direction of this division has been entrusted by the Government of the Dutch Indies to the undersigned, who will endeavor to maintain the work of his predecessor, with whom he had the advantage of collaborating during fifteen years, as he succeeded in carrying it on, and of conserving for the scientific institutions of the Botanic Garden of Buitenzorg the reputation they have hitherto enjoyed.

In giving the preceding notice, the undersigned expresses the wish that, to aid him in attaining the proposed end, he may receive your valued collaboration.

J. C. KONINGSBERGER,
The Director.

The College of Agriculture congratulates Dr. Koningsberger on his appointment and on his opportunity, and hopes that it will be able to be of some assistance to him in being a worthy successor of Treub.

The Botanic Garden of Buitenzorg was founded in 1817, by Reinwardt. His successors have been a series of noted botanists, perhaps the most eminent of whom have been Blume, Teysmann and Treub. Under the last of these, it became the finest and greatest botanic garden, not only in the tropics, but in the world. It was able to do this because it earned its way by service. The lessons learned and taught by the Buitenzorg scientists, and the impulse toward scientifically developed agriculture, which have gone out from this garden, have played a very large part in placing the agriculture of Java in its present rank. Koningsberger assumes no easy task when he undertakes to uphold the standards of Treub.

The botanic garden has an established place in most lands. That in Tokyo, Koishikawa, dates back to the seventeenth century. More than a century ago there was one in Manila, occupying at least a part of the present site of the Singalong station. Some gardens serve chiefly as public parks; what is called one in Manila serves this function alone. Some serve as places for especially advantageous and productive practical scientific study. Philippine agriculture needs the services of such an institution. Whether it is called an agricultural experi-

ment station or a botanic garden is a minor question. But it will be less likely to build houses without foundations, to give out information before it establishes it, if the promise of bulletins at once and at all times is withheld by giving it the latter title.

For many reasons, such an institution should be associated with or be a part of the College of Agriculture. Every consideration which made Los Baños the best site for the college makes it likewise the best place for a botanic garden. The two institutions, if they are made two, will have the same subjects, and can share equipment, preparation, information and conclusions. Much of the equipment of the college must be duplicated if a garden is established elsewhere. Its advanced students are a very important item of equipment which cannot be duplicated at any price. The operation of the college without provision and opportunity for research, in addition to the provision for instruction, is an economic waste.

The college does carry on experiments and studies. This Journal shows some of the results. But so long as it has no recognized function except instruction, so long as it must justify all expenditures on itself by the teaching it does to its own students, and so long as its faculty is overworked with teaching alone, it is not likely to accomplish a great deal in other directions. And there is a very great deal more which ought to be done.

The part of wisdom is to learn from the experience of others. The development of Javan agriculture justifies us in looking to Java for lessons. Is it not likely that the plan of organization by which she reached eminence in agricultural achievement, and to which she has returned after trying to combine research with administration, be a good plan in the Philippines as well?

E. B. C.

THE MANAGEMENT OF GARDEN SOIL

The conservation of the soil is a complex problem, which the gardener must be able to analyze. His success depends largely on his efficiency in soil management. He should, therefore, take care that in whatever he does he is correct, reasonable and economical. In the soil, fertility should be maintained by restoring the essential foods which the plants remove, else profitable gardening will be short-lived. The conservation of the soil is accomplished by the proper tillage, irrigation and drainage, use of fertilizers, and rotation of crops.

ROOT SYSTEMS OF CROPS.

The root systems of crops bear a most intimate relation to the management of the soil. Unless the gardener knows how roots behave, he can not make the most out of his soil. The roots, as we know, are the organs of plants used for taking plant foods in solution from the soil. The amount of plant food taken by plants from the soil is dependent upon the number of roots. Generally, the more the roots the greater the amount of plant food absorbed.

Roots advance into the soil with the protection of their root caps. If the soil is compact and hard, they can hardly penetrate it; but if it is moderately loose, their growth and activity are favored. In soil soaked with water, roots generally die. Those which can live grow near the surface of the soil, where the supply of water is moderate. When a dry season comes, they perish. In dry soil, roots penetrate deeply, primarily for the sake of water.

TILLAGE.

Experience has taught us that in order to produce profitable crops, the soil must be so tilled that the roots can penetrate it easily. If the soil is too compact, the roots are held tight. They can not advance easily, and the place from which they get food is therefore comparatively limited. A soil too loose is also undesirable; for most of the roots do not come in contact with the soil particles, around which they absorb the food. The soil must be broken fine to a depth of at least 15 cm.

For root crops and for legumes and other deep-rooted plants, the soil must be tilled deeper. It should be uniform. If there are parts left untilled in the first preparation, they should be made to conform with the rest. In a uniformly tilled soil, the temperature, the moisture, and the air are uniform. The plant foods are in all parts uniformly available. The plants, then, will be uniform in their development, and the uniformity of the crops will make it more likely to be profitable.

After the crops have been established, successive cultivations are necessary, the number of which depends on the weather, on the kind of soil, and on its previous preparation. If the soil has been very well prepared, successive cultivations will not need to be frequent. They may be rather deep when the crops are yet young; but when the crops have already started, they should be less frequent and rather shallow; for the roots have then occupied a large part of the soil, and are apt to be hurt. In dry weather, the soil should be cultivated fine and flat to avoid too much loss of water by evaporation; but in wet weather, the soil may be thrown into hills around the plants. This lessens the excessive amount of water around the roots and at the same time aerates the soil.

IRRIGATION.

In gardening, water is indispensable; it is not only food for plants, but also the agent which makes other foods available to plants. Several problems confront the gardener in applying water to his land: how much water he will apply; where he will obtain it; how and when he will apply it are the most important. As a general rule, the finer the particles of soil the greater the amount of water that can be held. Porous or leachy soils take in at once most of the water that is applied, but do not hold it well. On the other hand, clayey soils are soaked within a comparatively short time but are good water keepers. He should know that some soils are more retentive than others. Crops also differ in their need for water. Many need comparatively little to complete their life cycles; others need much. Some can stand drought; while others perish from it. The amount of water that will be applied to the garden varies, therefore, with the kind of soil and crop. Too little water is bad but too much is likewise injurious. Just enough is what is needed. While rules can be given, the fact is that in practice we can best learn by experience how much is needed for each crop and on any particular soil.

As pointed out on page 38 of this journal, ease of irrigation is an important factor in the selection of land. In delivering water to the garden, the first thing that the gardener should do is to determine the grade of his land. Then, if the water supply will be from a stream of water, as it generally will be, he should study out the location of a ditch or a pipe to bring the water to his land. In building the ditch, the grade and the size must be thoroughly considered. For a 5,000 sq. m. garden, a ditch 30 cm. deep, 30 cm. wide, trapezoidal in cross-section, and having a slope of one in one thousand is desirable. The main ditch should run along the highest part of the garden in order to make it easy to construct lateral furrows.

There are several ways of applying water to crops. They depend upon the kind of crop and the condition of the garden. There are a few crops which may be flooded; they should be planted in rectangular beds to make this method of applying water convenient. Water may also be allowed to run in furrows temporarily made along rows of plants. This method may be used for small fruit garden shrubs. A somewhat similar method to this, used when water can not be allowed to run in the garden, is to build furrows along or around the plants; the water may then be poured into the furrows, which are covered just after the water has percolated out. The last two methods have the advantage that comparatively little water is lost by evaporation. The most common method of watering plants in the Philippines, especially in towns, is by sprinkling. A mistake which is often made by beginners in gardening is to sprinkle the plants on the leaves. Nature has given roots the duty of taking up water, and it is to them that the water must be applied. It is injurious to water the leaves; for water may shut the stomata,

the breathing pores of the plants; or its weight may destroy the tender leaves; or it may cause blistering.

The need of water may be determined from the plants and from the soil. When the supply of water in the soil is insufficient, the leaves of grown plants curl or wilt. Old leaves fall abnormally, and appear dead or sickly. The leaves of newly transplanted seedlings often wilt in the sun; this may not be because the soil contains insufficient water but because the roots can not yet supply the leaves with the amount of water sufficient to keep them fresh. An accurate way of determining whether land needs irrigation or not is to examine the soil a few inches below the surface. If the soil particles are dry, there is, of course, need of irrigation; but if they are moist, and adhere to each other, irrigation is not necessary. However, it is advisable to supply the crops with sufficient water before they begin to suffer.

CONSERVATION OF MOISTURE.

Especially in the dry season, the conservation of moisture in the soil needs attention. The amount of water to be supplied may be much lessened by correct methods of storing the moisture in the soil. Soil deeply tilled can absorb much water, and can keep a large amount of it. The soil should be so tilled before rain or irrigation, after which cultivation must follow just when the lumps of soil will crumble readily. Water may be lost from the soil by sinking or by escaping into the air. The loss by sinking can hardly be prevented; but that by escape into the air can be largely checked. The deeper one makes it fine the better, for less chance is given to the water to escape.

DRAINAGE.

Too much water in the soil is just as injurious as an insufficient amount of it. If the soil is soaked with water, it delays the work in the garden. It also delays plant growth. The air between the soil particles is excluded. Air, in which oxygen is the important constituent, is essential in the soil for the decomposition of organic matter, from which available plant foods may be obtained. It is needed by roots, micro-organisms, and germinating seeds. Without air, they all perish. In order to supply the soil with air, the surplus water in it must be removed. This can be done by building ditches along the lower border of the garden. Several ditches may be built if the garden is big.

ENRICHMENT OF THE SOIL.

The plant foods in garden soils are sooner or later exhausted. Its exhaustion varies directly with the grade of continuous intensive cropping. If the plant foods in the soil are already exhausted, the gardener has either to change the location of the garden or to replace with fertilizers the plant foods taken out. The foods that are needed by plants in large quantities are nitrogen, phosphoric acid, and potash. Soils differ in their need for fertilizers. The presence of a large amount of nitrogen on the soil is shown by vigorous growth and deep color of stems and leaves. Potash is found especially in young tissues of plants, and is essential in the making of starch. Phosphoric acid is found in seeds, and is probably an essential part of the protoplasm. Fertilizers may be bought from dealers but this is not always necessary. Nitrogen may be obtained from dried blood, phosphoric acid from bones, and potash from wood ashes. Animal manures, the value of which is not yet commonly well known in the Philippines, are excellent fertilizers, especially when they are already rotten. The three kinds of plant foods that are most needed by plants are found in them.

Fertilizers may be applied to the soil broadcast. They may then be turned under with the plow or spade. Stable fertilizers should be placed in the soil during the preparation; but those fertilizers which are very soluble should be placed in the soil when the plants are ready to take them up.

ROTATION OF CROPS.

Any one kind of crop takes practically a fixed amount of each kind of foods from the soil, and related crops take nearly the same amount of each kind of food.

The proportion of plant foods in the soil will be left unbalanced if the same kinds of crops are grown on it for years. To keep these plant foods in proper proportion for various kinds of crops, fertilizers should be used to replace those removed; or a proper rotation of crops should be practiced. It should be borne in mind that different kinds of soil need different systems of rotation of crops.

T. N. VIBAS

Current Literature

RUBBER IN CEYLON

The Royal Botanic Gardens issued last year ten numbers of Vol. V of their Circulars and Agricultural Journal, giving an extensive account of the different phases of the rubber industry. The following is an extract from these circulars.

Dr. John C. Willis, Director of the Royal Gardens, in his article "Rubber Cultivation in Ceylon," reprinted from No. 4 of Vol. I of these circulars issued Jan. 27, 1898, says: "The growth of the cycling trade and other industries in which rubber is used has caused a great increase in the demand for rubber. That the price has not correspondingly increased is chiefly due the discovery in West Africa of a new rubber-yielding tree, Kickxia africana. The collection of rubber from wild trees is carried on in a reckless manner, and the trees are being gradually exterminated. The rubber collectors have thus to go further and furhter inland every year for their supplies, and the cost of the rubber is increased by the difficulties of transport. There seems therefore a likelihood that the planting of the best kinds of rubber may prove a profitable industry."

The world's consumption of rubber is now (1898) over 100,000,000 lbs., worth more than 48,600,000 dollars yearly. One-third to one-half of this world's consumption is supplied by Para.

There are many trees belonging to Euphorbiaceae, Urticaceae, and Apocynaceae, which yield rubber in different parts of the world. But the kinds most likely to be useful in cultivation are Pará rubber (Hevea brazilensis), Ceará rubber (Manihot Glaziovii), of the Euphorbiaceae; Panama or Mexican rubber (Castilla elastica), and Assam rubber (Ficus elastica) of the Urticaceae.

The first importation of Pará into Ceylon was made in 1876, when some young plants were obtained from Brazil and planted in the Garden at Henaratgoda. Seeds from these have been planted in the Botanic Gardens from time to time and there was now over 450 trees in these gardens producing 100,000 seeds per annum. These seeds are sold to private planters.

There are now (1898) about 200,000 trees of various ages all over Ceylon planted on about 150 acres.

Ceará rubber did not prove profitable in Ceylon, although it grew very well there. Panama rubber is also scarce. Pará rubber is well suited to the climate of the low country in the Southwest of Ceylon, and is the kind that brings the highest prices in the market.

As to the climatic requirements of Pará rubber, Dr. Willis gives that of Para as described by Trimen: "The climate is remarkable for its uniformity of temperature, usually not exceeding 87° Fahrenheit at midday, or below 74° at night. The greatest heat recorded is 95°, and the mean for the year is 80°. The rainfall occurs principally during the months from January to June, the maximum being in April when it reaches 15 inches. For the remaining six months of the year very little falls but there are fine days in the wet season, and occasional showers in the dry. The whole country is covered with dense, moist forests, and the soil near the numerous and gigantic rivers is deep, heavy and very fertile....." Dr. Willis then adds: "From the description of the climate of Para quoted above, it will at once be evident that only the wet, low lying country in the southwest of Ceylon is suitable for the growth of Hevea....."

Para rubber requires "fairly flat land, at about sea level, with alluvial soil, preferably jungle land, and not sandy. The land should not be subject to frequent floods or strong winds."

Hevea begins to flower when about six years old, but seeds from more mature trees should be used for planting purposes. The seeds are short lived and should be planted not later than a week after falling. If seeds are sent to distant countries, they should be planted in soil in a Wardian case and allowed to grow on the way.

In germinating seeds, they should be sown about an inch deep in well prepared soil in nurseries, or in bamboo pots, and kept shaded, and watered. The seedlings are transplanted when 18 in. to 24 in. high. Pará rubber is also propagated by cuttings taken near the ends of the branches, but further back than any of the leaves.

As to the rate of growth of Para rubber, the following measurements, taken in the plantations of the Forest Department near Ratnapura, are given. The measurements were obtained by taking the mean girth at three feet from the ground.

At Edangoda (4 years old), mean of 100 trees	12.96 in.
At Edangoda (3 years old), mean of 50 trees	8.75 "
At Edangoda (2 years old), mean of 20 trees	4.96 "
At Yattipowa (3 years old), mean of 108 trees	9.37 "
At Yattipowa (3 years old), mean of 108 trees	9.13 "

Trees should be tapped when they have reached a girth of two feet.

As to the form of tapping, J. Perkin, in his article on caoutchouc reprinted in Vol. V, No. 3, from Vol. I, Nos. 12-14, says: "Oblique incision gives most, and especially double oblique in the form of a V, made with mallet and chisel."

However, herring bones and similar long continuous incisions are now in use.

This article may be said to mark the beginning or rapid rubber-planting in Ceylon. Experience has since shown that rubber can be raised and produced more cheaply and in a shorter time than Dr. Willis stated in 1898; and the price has risen above the fondest hope of that day. The profits, therefore, have, on succesful plantations, been far above the 27% which he thought could be anticipated. The soundness and safeness of his judgment have certainly been well proven.

The effect of different intervals between successive tappings was investigated by M. Kelway Bamber and R. H. Lock in June 1908. Dr. Willis had discovered the wound-response in 1897 when he found that his second tapping gave a larger yield than his first, the second and third usually being very productive. The interval between his tappings was one week. Parkin in 1899 had recorded the yield of fourteen successive tappings with an average interval of six days. He obtained in all fourteen tappings 3,503 cubic centimeters of latex, the yield for his first tapping being 61.00 c. c. and for his last 449.00 c. c., an increase of six hundred per cent. His experiment was conducted from March to June.

This experiment of Bamber and Lock was made upon seventy trees more than twenty years old in one of the plantations of the Tropical gardens. Seven rows and ten trees in each were chosen. The trees in the first row were tapped every day, those of the second, every two days, and so on.

Their system of tapping, as given on page seventy-four, was as follows: "The tapping began with three wide V's arranged vertically one above the other and joined by a vertical chanel. The V's extend exactly half way round the tree. The original cuts are one foot apart in a vertical direction and the lowest cuts enter the vertical channel at a height of one foot above the ground level. Tapping was carried out with the Bowman-Northway paring knife, followed by the sharp pointed pricker....." In another paragraph they add: "It should be pointed out that the

system of tapping employed in these experiments is not recommended for practical estate work. The only advantage which caused it to be adopted in the present instance is that it is comparatively easy by this method to ensure that each tapping operation covers a precisely comparable area of each tree....."

The result of their experiment is summarized as follows:

"1. The wound response, although clearly recognizable, is not nearly so marked as in the case of Parkin's experiments. The greatest increase in yield of dry rubber was in no case much more than one hundred per cent.

"2. Taking the first forty tappings of each series, there is no sensible difference in yield which can be ascribed to the length of the interval between successive tappings. The yield from trees tapped daily and from trees tapped weekly is practically identical for the same number of tappings, both in the gross and in proportion to the area of the bark tapped.

"3. During the first few tappings the rate of fall in the percentage of rubber contained in the latex is more or less inversely proportionate to the length of the interval between successive tappings, the fall being more rapid as the tappings succeed each other at shorter intervals. Sooner or later a nearly constant percentage composition of the latex is arrived at. This final percentage is lower in the case of trees tapped at short intervals than in the case of trees tapped at longer intervals.

"4. As might be expected from the less concentrated condition of the latex, the proportion of scrap rubber obtained is lower in the case of more frequent tappings.

"5. Mature trees tapped daily for eighteen months continue to afford a profitable yield of rubber. After yielding over seven pounds of rubber per tree in this period, the average yield at the four hundred-fortieth tapping was at the rate of four pounds of dry rubber per tree annually. The general appearance of the trees at this time was quite healthy and they showed no signs of having suffered from the severe tapping which they had undergone."

Root Diseases of Hevea

Mr. T. Retch in his article "A Root Disease of Hevea" published in Vol. V, No. 8, gives the following (pg. 69).

"The following details will serve to distinguish between the root diseases which are at present known to attack Hevea:

(a) Root encrusted with sand and stones, cemented together by a brown or black mycelium—*Hymenochaete noxia*. Usually common in old cacao land, and may be avoided by removing cacao stumps. Trenching not necessary.

(b) Root covered with white or yellowish stout cords of mycelium—*Fomes semitostus*. Fructification in the shape of overlapping plates red-brown above and orange beneath; usually occurs in a neighboring stump. This stump must be extracted. Usually the stump is a jak, but the fungus has been found also on Bombax. The affected area must be trenched round.

(c) No external mycelium; dark-red or (when decayed) black strands running between the wood and the cortex of the root—*Sphoerostilbe repens*."

Treatment of these fungus diseases: dead trees to be dug up and burned, stumps, roots, and all. Affected area to be surrounded by a trench about a foot in depth, to prevent the spread through the soil by means of rhizomorphs. The ground enclosed within the trench to be dug over and dosed with quicklime, which should then be forked in.